'Unusual' feeds for performance horses

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Abstract

Equine feeding and stable management practices for horses kept around the world vary greatly and very few people, feed just a simple single grain or compound feed plus roughage diet. Especially in the developed countries many add other separate feeding stuffs and supplements in order to personalise the diet, add that little bit extra to boost performance, improve health, correct an imbalance etc. Some of these supplementary feedstuffs that we add today have been included in the diets of horses for centuries: Garlic being one such example '*Before 1733 the diet [of racehorses] consisted of barley, beans, wheat-sheaves, butter, white wine and up to 25 cloves of garlic per feed'* . However, the feeding practices of adding ale and dairy products is perhaps less prevalent today than in the 1700s when *new strong ale and the whites of 20 eggs or more, with no water'* was recommended. This paper will consider some of the less well discussed supplementary feedstuffs that are or perhaps should be added to performance horse's diets including the role of certain spices such as fenugreek as palatants, and the potential health benefits of cinnamon and curcumin .It will also discuss the potential role of the 'ultra' trace and rare earth elements.

Keywords : Spices, equine, health, silicon, rare –earth elements.

Introduction

As the role of the horse has changed over the centuries, so have the conditions under which it is kept. The nature of equine diets in the past has depended, to a certain extent, upon where they lived and what feedstuffs were available. For example, at the beginning of the last century Kulthi, Gram, Moth, Urad and Mung (Indian beans/peas) were commonly fed ingredients (according to an UK published animal management book –anon 1908) and this probably reflected the geographical destination of the manual. This particular manual also stated that 'meat was utilized successfully during the siege of Metz by being cut into small pieces and rolled in bran, and Norwegian stock of all kinds is accustomed to consume a soup made from boiled fish when mixed with other food'. Although the use of meat would be frowned upon altogether today, Icelandic ponies apparently may still be fed herring in the winter. In some countries horses are fed a very different and wide variety of vegetables and fruits compared with the UK and parts of mainland Europe. Horses in some less developed countries may at times survive on very diverse feedstuffs, including cardboard soaked in a sugar solution, which are unlikely to be on an European horse's menu.

Feeding and stable management practices around the world therefore still vary greatly and very few people feed just a simple single grain or compound feed plus roughage diet. In developed countries many add separate feeding stuffs and supplements in order to personalise the diet, add that little bit extra to boost performance, improve health, correct an imbalance etc. Some of these supplementary feedstuffs that we add today have been included in the diets of horses for centuries: Garlic is one such example 'Before 1733 the diet [of racehorses] consisted of barley, beans, wheat-sheaves, butter, white wine and up to 25 cloves of garlic per feed' (Harris 1999*).* However, the feeding practices of adding ale and dairy products is perhaps less prevalent today than in the 1700s when ' The above were kneaded together and mixed with Barm (the froth on the top of fermenting malt liquors or yeast leaven) and Lightning (a strong alcoholic spirit) with only a little water and then baked. It was recommended that the bread should not be given before it was 3 days old at least and then mixed with oats. By the Fourth Bread the diet had been expanded to encompass yet more dairy products. The lightning was now replaced by new strong ale and the whites of 20 eggs or more, with no water' (Harris 1999). Conversely the addition of herbs (plants grown for culinary, medicinal, or in some cases even spiritual value, http://en.wikipedia.org) to equine diets appears to be on the increase. They are commonly included for their aroma and perceived palatability as well as their potential medicinal value. Many potential claims for the health benefits of herbs have been made for man and the horse, in particular with respect to respiratory and digestive problems as well as for pain management (Davidson, 1999, Wirth et al 2005). There has, however, been very little published research on the medicinal effects of herbs in horses but recently there has been some work on their effect on palatability as discussed below. Herbs themselves will not be discussed in this paper in depth, but it is obviously important to be aware that some herbs could be considered as medicines e.g. in other species, herbs such as Valerian have been shown to be effective sedatives. Yet there has still been little work in the horse on both the short and long term benefits OR concerns of herbal preparations. Here in particular, an important consideration is safety. The fact that certain herbs have been fed for centuries does not mean that they are always safe, this is illustrated by garlic mentioned above. Recent work has suggested that high intakes as well as long-term administration may have adverse effects in the horse (Miyazawa et al 1991, Person et al 2005). There are also potential conflicts with certain medication rules within the equine industry, and the line between some herbs acting as calming agents or sedatives can be very fine. Cross-reactions and contraindications are known to occur between certain medicinal / drug therapies and herbal preparations (see reviews by Johne & Roots 2005, Williamson 2005). For example, it has been suggested that gingko should not be used alongside and in conjunction with aspirin, NSAIDS or other anti-coagulants due to ginkgo's platelet activating-factor properties (Davidson, 1999).

This paper will consider some of the less commonly discussed supplementary feedstuffs that are, or even perhaps should or should not be, added to the diet of horses diet today.

Spices.

A clear definition of exactly what distinguishes a herb from a spice seems to be difficult to find. Collins dictionary has herbs as 'any of various usually aromatic plants, such as parsley and rosemary that are used in cookery and medicine' and spices as ' any of a variety of aromatic and vegetable substances such as ginger, cinnamon, or nutmeg used as flavourings'.

The Seasoning and Spice association suggest the following:
(http://www.seasoningandspice.org.uk/background.asp).

- **Herbs** are the leafy part of the plants, which are commonly added to foodstuffs for their natural flavouring, aromatic and visual properties.
- **Spices** are parts of the plants, including but not restricted to the roots, rhizomes, bark, leaves, foliage, flowers, buds, fruits, seeds, which are commonly added to foodstuffs for their natural flavouring, aromatic and visual properties.

The American Spice Trade Association explains that spices were historically referred to as tropical aromatics whilst the term 'herb' referred specifically to the leaves and seeds of certain temperate-zone plants (http://www.astaspice.org/spice/frame_spice.htm). While these distinctions are still used, the term 'spice' has perhaps evolved to also mean the whole family of dried plant seasonings, including spices, herbs, blends and dehydrated vegetable. In effect, some plants may therefore be both herbs and spices and both herbs and spices have been used in perfumes and cosmetics, and many have been used for medicinal and religious purposes.

Spices as Palatants

Owners commonly (and historically) add "extras" to their horse's diet including apples and carrots as succulents, give mints as treats and add herbs as a supplementary addition for a variety of reasons as outlined above. Both herbs and spices are sometimes added to increase the palatability of the feedstuff although until more recently, little has actually been known about flavour preference in horse.

Many stabled leisure and competition horses are routinely maintained on restricted forage diets plus concentrate rations, whereas, feral and free-ranging horses daily consume over 50 forage varieties (Goodwin et al *2005*). In a study investigating olfactory attractants and repellents for horses *(*Bonde & Goodwin *1999)* significant differences in odour preferences of herbs, spices and natural oils in stabled horses were reported and Coriander was shown to be a preferred odour. In more recent studies, however, (Goodwin et a*l 2005*), Echinacea, Nutmeg and Coriander were totally or partially rejected by three out of the eight horses studied (38% of the study group). The top eight ranked flavours in the initial trials were three herb flavours (Peppermint, Oregano and Rosemary), two curry spice flavours (Fenugreek and Cumin), two fruit flavours (Cherry and Banana) and a vegetable flavour (Carrot). There appeared to be individual differences in preferences for the flavour types, with some horses preferring curry flavours and others the fruit flavours. Subsequent paired preference tests using these top eight flavours showed the following order of preference;

Fenugreek > Banana > Rosemary > Carrot > Cherry > Cumin > Peppermint > Oregano.

The final trial in this study showed that the relative consumption times of 100g mineral pellets flavoured with Fenugreek and Banana were significantly reduced in comparison with unflavoured pellets over 5 days. But, can these spices add anything else to horses' diets apart from acting as palatants?

Spices and health

Fenugreek

Fenugreek (*Trigonella foenum-graecum*) itself is commonly used as a spice and often as a flavouring in Indian cooking. This seed spice has been used for medicinal purposes in many traditional systems around the world (Srinivasan 2006). A number of potential benefits have been suggested based on animal studies and human trials including in particular an anti-diabetic effect and an hypo-choesterolaemic influence. In addition, it has been suggested to have potential antioxidant activity and an ability to act as a digestive stimulant (PDR, 2000, Srinivasan 2006). Its proven medicinal effect in horse, if any, remains to the authors' knowledge 'unknown'. Feeding Fenugreek at 20% of the dry matter intake to cattle did not result in any clinical problems and in fact improved milk characteristics (Shah & Mir 2004). Therefore, as fenugreek appears to be palatable to the horse and with clinical studies reporting anti-oxidative properties (a study by Dixit et al, *2005* showed significant antioxidant activity in germinated fenugreek seeds along with the presence of flavonoids and polyphenols) further investigations are perhaps warranted in the horse.

Trials on Fenugreek in other species however, illustrate a major issue when trying to evaluate the efficacy of herbs and spices for example some trials have and others have not shown an effect on blood glucose (Srinivasan 2006, Jelodar et al 2005). This may reflect study design and the choice of model used but also the nature of the herb or spice used in the different trials. They are not manufactured materials where quality control should help to ensure consistency of efficacy from batch to batch, instead they are natural ingredients and many factors can influence the concentration of the active ingredients in the final nutritionally administered product. These include the genetic strain of the original plant, growing conditions, harvesting, storage, processing and extracting. This has been highlighted in some recent work looking at Fenugreek where considerable variability among fenugreek genotypes has been reported with significant differences in morphology, growth habit, biomass and seed production capability (Acharya et al 2006). In particular the chemical constituents of the seed, e.g. saponins, fibre, protein, amino acids and fatty acid contents differed markedly. This variability (genetic variability and genotype by environmental interaction) is most often overlooked or underestimated in clinical trials but may play a significant role in any intervention study.

Cinnamon

As for Fenugreek there are a number of cinnamon species (the most commonly used are Cinnamomum zeylanicum, aromaticum and burmanii) and the chemical composition of the cinnamon varies with species and geographic sources (Chericoni et al 2005). Cinnamon is an aromatic substance from which essential oil is extracted, it is said to be one of the oldest spices in the world and is derived from cinnamon trees of the genus cinnamomum family lauraceae which are mainly found in tropical countries, such as India, south china etc. Cinnamon bark is probably the most commonly known form of cinnamon and is said to act as a stimulant astringent to the stomach with anti-microbial, antispasmodic, antioxidant, anti-diarrhoea, calmative and anti-parasitic properties (PDR, 2000). Cinnamon has therefore been suggested (although proven evidence as to efficacy is not always available) to be ingested in order to aid weak digestion, to promote the secretion of gastric juices, soothe the symptoms of irritable bowel disease and ease the effects of bodily infestation such as lice. Other suggested benefits include bone-healing properties, however, perhaps recently the majority of the interest is based around its potential natural insulin sensitising action. Type 2 diabetes is the most common human metabolic disease and although horses rarely if at all suffer from this condition other important equine conditions have been linked with problems with glucose homeostasis perhaps most importantly laminitis (Harris et al 2006).

Cinnamon's suggested anti-hypoglycaemic properties, therefore may be beneficial to the diabetic sufferer. A study in humans suggested that even low levels of cinnamon (1g/day of cinnamomum cassia) in addition to the diet could have significant effects on fasting glucose concentrations (Khan et al 2003). In a study by Kim et al (2005) it was found that levels of blood glucose in rats (a type II diabetic animal model) were significantly ($P<0.001$) decreased when supplemented with 200mg/kg cinnamon extract when compared to a control. Triglycerides and total cholesterol were lower whilst HDL (high-density lipoprotein) cholesterol and levels of serum insulin were significantly higher ($P<0.01$) after 6 weeks. Thus suggesting that cinnamon extract may play a role in blood glucose levels by improving insulin sensitivity or the release of insulin or by slowing the absorption of carbohydrates. The exact identity of the proposed bioactive component of cinnamon is under debate (Vanschoonbeek et al 2006) and these latter authors also challenge the original work by Khan et al 2003 as in their perhaps more controlled study no beneficial effects on fasting blood glucose, insulin sensitivity etc could be found. Further work is obviously needed in man to reconcile these differences and to further evaluate the apparently positive effects in rats and other species. In the meantime the sales of cinnamon containing products for diabetics increase.

What about the horse? Again, the author is unaware of any studies that have been carried out in horse; however, this has been suggested to be a potentially fruitful area for evaluation, especially with respect to laminitis where insulin resistance may be involved (Harris et al 2006). Plus cinnamon along with other herbs and spices also contains proanthocyanidins which are suggested to have a number of health benefits including substantial antioxidant activity and improved vascular health – these may also be important in conditions such as laminitis. Finally is there any role for the apparent antifungal activity of essential oils extracted from cinnamon (Angelini et al 2006)?

Lastly, a comment on safety – it has been suggested that both the seed and the essential oil have the potential to cause allergic reactions (via the cinnamaldehyde) such as skin irritations (Reimers & Muller 2005).

Curcumin /Turmeric

Turmeric is the rhizome or underground stem of a ginger-like plant Curcuma longa L. Curcumin is the biologically active phytochemical ingredient of turmeric. It is a polyphenol with a molecular formula $C_{21}H_{20}O_6$ (diferuloylmethane). Curcumin can exist in at least two tautomeric forms, keto and enol. The keto form is preferred in solid phase and the enol form in solution.

Turmeric contains sesquiterpenoids which together with the curcuminoids have been suggested to have anti-oxidative, diuretic, laxative, anti-hepatoxic, anti- hyperlipidemic, anti-carcinogenic, and anti-inflammatory activities (PDR, 2000, Aggarwal & Shishodia 2004, Nishiyama et al 2005, Srinivasan 2005). Again, perhaps due to the importance of this area in human health, as for cinnamon, primarily research has been undertaken to look at the potential for this spice to affect glucose and lipid metabolism. Turmeric/curcumin were found to be effective as hypochoesterolemic agents under various conditions of experimentally induced hypercholesterolemia/ hyperlipaemia/hypertriglyceridaemia in rats (Srinivasan 2005). Recent work has shown that that both curcuminoids and sesquiterpenoids in turmeric exhibit hypoglycemic effects via human peroxisome proliferator-activated receptor-γ (PPAR-γ) activation as one of the mechanisms, and suggested that preparations including both curcuminoids and sesquiterpenoids may have additive or synergistic effects (Nishiyama et al 2005). Other work has concentrated on the role that curcumin might play in inflammation and cancer. Its anticancer effects stem, it has been suggested, from its ability to reduce tumour cell survival, tumour expansion and inflammation via nuclear transcription factor κB inhibition (Surh 2003). As activation of NF- κB has been linked with a variety of other inflammatory conditions including asthma, osteoperosis, arthritis, Alzheimer's disease and AIDS curcumin has been suggested for these conditions as well (Aggarwal & Shishoida 2004). An article on the New scientist website suggests that turmeric may protect against childhood leukaemia due to its powerful antioxidant activity – and suggests that curcumin is undergoing further safety evaluation in humans. Certainly there is some evidence for the antioxidant potential of curcumin and the other curcuminoids (Jayaprakasha et al 2006).

However, once again no work has been done to the author's knowledge on the use of curcumin in the horse but there is perhaps sufficient evidence in other species to suggest that this might be of value. Interestingly one study suggested that the oral administration of curcumin to mice infected with malaria parasite actually reduced blood parasitaemia by 80 – 90% and enhanced their survival significantly (Reddy et al 2005) – obviously malaria is not an issue for the horse but could other such conditions, that are found in the horse possibly affected by curcumin??

What about safety? Curcumin is often referred to as a non-toxic pigment or similar. Srinivasan 2005 suggested in the review that safety issues (at dose levels currently used) had been addressed for turmeric and its active principles in animal and human studies. This author points out that ' CFTRI played a major role in establishing the safety of turmeric (curcuma longa) and its yellow colouring principle curcumin as required by WHO/FAO'. But are such studies representative for the horse? – they are certainly an useful starting point. However, interestingly in this review, it is suggested that the mechanism of digestive stimulant action of common spices examined in experimental animals may be mediated through phenomenal stimulation of bile secretion with an enhanced bile acid concentration (ingredients essential for fat digestion and absorption) and an appropriate stimulation of the activities of digestive enzymes of pancreas and small intestine. Would such bile secretion stimulation – if it occurs in the horse (already a continual bile secretor) be positive or negative for the horse. Other work has suggested that Curcumin can have adverse effects on cells under certain circumstances which may in turn be positive or negative depending on the situation. A study done by Kelly *et al*. (2001) on human leukaemic cells suggested that under certain conditions curcumin might have pro-oxidant activity based on its effects on the DNA pattern achieved by alkaline gel electrophoresis (COMET). The authors suggest that curcumin might prevent tumorigenesis by inducing apoptosis in newly emerging cancer cells via promoting the formation of reactive oxygen species, which then cause irreparable oxidative damage of cancer cell DNA and consequent initiation of apoptosis. What the relevance this has in healthy cells is unknown and these effects could be suppressed by the lipophilic antioxidant, α-tocopherol.

Other spices

It is not possible to go into any detail of other spices and their potential for use in the horse in this review – but work is starting in the horse to explore this area. For example Liburt et al 2005 reported on a study looking at the effects of ginger and cranberry extracts on markers of inflammation and performance following intense exercise. This preliminary study suggested that the ginger extract might reduce recovery time but there was a potential negative in that ginger had a tendency to promote upregulation and expression of certain pro-inflammatory cytokines whereas the cranberry extract tended to attenuate this upregulation.

Finally, unrelated to the spices themselves may be health hazards linked to the production and storage of spices as investigated by Aguilera et al, 2005. The aim of this study was to investigate the sanitary quality of some spices in San Luis, Argentina and to determine the presence and characteristics of enterotoxigenic Clostridium perfringens. Results showed that ~30% exceeded the standard set for colifecal counts and a total of 14 Cl. perfringen strains were isolated, four of which were enterotoxigenic. The results provided evidence of poor sanitary conditions during the processing and handling of the spices which highlighted the need to improve the hygienic production and storage facilities of spices.

Unusual trace and 'ultra' trace elements

Minerals may be thought as being *essential* if they are necessary for reproduction, growth and/or health or *non-essential* if they are not needed to sustain life and are simply products of our geochemical origins or indicators of environmental exposure. However, some of these nonessential elements may be beneficial to health if they have certain pharmacological properties. Trace elements can be described as all those elements of the periodic table, which are required in the diet in mgs/day. The term 'ultra' trace elements has been used for several decades to refer to those elements which are normally needed in quantities of less than 1mg/kg diet. Many of these are more commonly considered, as being toxic and this aspect will not be discussed here. However, circumstantial evidence suggests that aluminium, arsenic, bromine, cadmium, germanium, lead, lithium, nickel, rubidium, silicon, tin and vanadium could be essential for health and wellbeing - with the best evidence being available for arsenic, and silicon together with possibly nickel and vanadium (Uthus et al 1996, Perez-granados & Vaquero 2002). Estimated daily allowances have been calculated for humans (Uthus et al 1996) which should be met by typical diets but there is little known about situations where low intakes or impaired bioavailability of these ultra trace elements may contribute to various diseases.

In this review we consider two elements within this category, where there are no daily allowances currently provided for the horse but where some research has been carried out.

Silicon

Although Silicon is considered by some to be a trace element, others refer to it as an ultra trace element. After oxygen, Silicon is the most common element of the earth's crust and together oxygen and silicon make up the major part of soil and sand. Silicon after iron and zinc is the third most abundant trace/ultra trace element in the human body (around 140 – 700mg in total). The soluble form of silicon (Si (OH) 4 or orthosilicic acid) is thought to be health beneficial and is the most readily available source of silicon at least for humans (>50% available: Sripanyakorn et al 2005). It is a normal constituent of natural drinking water or is derived from certain plants as 'phytolithic silica', which can be broken down and absorbed in the gastrointestinal tract of humans. Amongst plant based foods whole grains have the highest amounts of silicon as does wheat bran but processing reduces the level (Sripanyakorn et al 2005). Certain root vegetables such as carrots are reasonably high in Silicon but for some unknown reason the Silicon does not appear to be as well absorbed from such feeds (Sripanyakorn et al 2005). Factors such as ageing and the reduction of oestrogen levels appear to reduce the ability to absorb silicon as does exercise – suggesting that athletes may require increased amounts in the diet (Perez-granados & Vaquero 2002). However, minimum recommended levels have not been established for man or other animals although levels have been suggested at 10-25 mg for adults and 30 – 35 when exercising (Sripanyakorn et al 2005, Perez-granados & Vaquero 2002). Silicon deficiency (perhaps associated with the depletion of other nutrients) in some animal studies has however, been linked with abnormal connective and bone tissue metabolism and may result in delays in growth, bone deformations and abnormal skeletal development (Perez-granados & Vaquero 2002, Sripanyakorn et al 2005).

Whilst, little is known of the role of dietary silicon in bone health of both humans and horses, it is thought that soluble silicate may be advantageous in promoting collagen formation and therefore be of benefit for hair, skin and nails in particular. Research suggests that dietary silicon intake is positively correlated with bone mineral density (BMD) at four hip sites in men and pre-menopausal women (Jugdaohsingh et al, 2004). This positive correlation was not found in postmenopausal women. Interestingly this study suggests that some of the effects seen for moderate consumption of alcoholic beverages on bone mineral density many be due to silicon intake!. Most of the work suggests that any effect of silicon on bone may be through stimulation of bone formation although a few suggest it may also have an effect by inhibiting bone re-absorption (Sripanyakorn et al 2005).

Not surprising perhaps given the importance of skeletal growth and development in the horse, silicon is one of these elements where there has been some work carried out in the horse! Work using human osteoblast cells suggested that the addition of Zeolite A, a Si containing compound, would significantly increase osteoblast proliferation and differentiation and in 1992. Frey et al (1992) used 60 quarter horses to determine the ability for various levels of SZA) to increase plasma silicon levels in addition to increasing radiographic bone density. Feeding the SZA resulting in an increase (P<05) in plasma silicon concentrations (though this was not consistently correlated with dose there appeared to be a possible trend), thus, suggesting that SZA was a bioavailable source of silicon for the horse. Radiographs of the anterior-posterior of the third metacarpal were taken at the start of the trial and at 56 day intervals with bone density being expressed as radiographic aluminium equivalents (RBAE). Whilst the RBAE gain seen during the first 56 days of trial was the largest, there was no significant difference in RBAE between levels of SZA fed over the 168-day trial as a whole. Further to this study, Nielsen et al (1993) went on to look at the addition for 30 days of varying amounts of SZA to the diet of 18month old quarter horses in training. Results confirmed the findings of the Frey et al (1992) study in that plasma silicon concentrations were increased in all horses fed SZA (irrespective of amount fed) when compared to the control group. A correlation of 0.54 was seen between plasma silicon concentrations and distance travelled, during training and racing cycles, before injury which may suggest that SZA may help to prevent injury in athletic horses. Increased plasma silicon concentrations were not seen to be detrimental to performance as faster average race times were seen in treated horses though not significant when looking across all distances. In 2001, the effect of supplemental dietary silicon (sodium zeolite A: SZA) on plasma and milk silicon concentrations of lactating mares and the subsequent effect on plasma silicon concentrations in nursing foals was investigated (Lang et al, 2001). All supplemented mares and supplemented mares milk had higher levels (P<0.01) of plasma silicon and silicon concentrations by days 30 and 45 respectively. Foals of mares supplemented also had higher plasma silicon levels (P<0.01) concentrations by day 45. While supplemental silicon did not influence bone metabolism (plasma silicon concentrations were not seen to be higher in supplemented foals until the last study day) (P>0.36), trends were observed in postpartum mares (P<0.10). Results therefore indicated that supplemental dietary silicon may indicate an increase in both milk and plasma silicon levels in mares and foals. Lang et al in 2001b reported on a study in twenty yearlings (ten Quarter Horses and ten Arabians) half of which were given 2% of the total diet as SZA, and the others no such supplement. Supplemented yearlings had higher plasma Si concentrations than the controls by day 15, and remained higher when subsequently sampled during the 45 days of the trial. There were no differences between treatment groups for osteocalcin or pyridinoline and deoxypyridinoline crosslinks concentrations however, ICTP concentrations were lower in the supplemented yearlings on day 45 when compared to the control group which the authors suggested might mean that there was decreased bone resorption, which might in turn provide for greater net bone formation - BUT this is currently unproven. Recent work comparing the availability of silicon from Sodium Zeolite (synthetic) or a more natural form of silicon Azomite A suggested that the Si source effected Si utilization and/or absorption as those fed the synthetic source had higher plasma silicon concentrations during the period of supplementation whereas those on the natural source had a lower level but this was does not appear to have been a cross over trial (Mazzella et al 2005).

Future work on the role of silicon in the horse is obviously needed – before any real conclusions can be given - but there also may be other possible roles for this element – as silicon based gels and cements appear to facilitate healing (Sripanyakorn et al 2005).

But, what about safety? In a report on the Safe Upper Levels for Vitamins and Minerals (May 2003) from the Expert Group on Vitamins and Minerals from the FSA it says ‘ few data are available on the oral toxicity of silicon in humans and no acute or chronic toxicity data have been identified. The occurrence of silica stones has been reported in patients on long term antacid therapy with magnesium trisilicate.' 'No significant toxicity or mortality has been reported in animals given doses of up to 3g/kgbw/day.' But 'growth rates were reduced and the concentrations of certain other minerals in the plasma and tissues were affected in rats fed 500ppm (equivalent to approximately 50mg/kg bw for young rats)'. Work recently reported (Turner et al 2005) in calves (which might not be the ideal model for the horse) that were either fed 0.5% BW of Sodium Zeolite A or not with their milk replacer showed not effect on the weight of average daily gain, but there was an increase in the levels of deoxypyridinoline in the supplemented calves (unlike the decrease noted in the horse study above) which tended to have longer metacarpi although there was no effect on mechanical properties. Whilst this might mean that silicon may aid the rapid repair of subclinical injuries rather than prevent damage as suggested by the authors – differential alterations of growth patterns in the horse may not be desirable.

Chromium

Trivalent Chromium (Cr) is not made by the body and is therefore recognised as an essential trace element that needs to be provided by the diet. In humans in 2002 the Food and Nutrition Board of the Institute of Medicine of the National Academies of Science established the adequate intake level of Cr as being 35 and 25ug/day for young men and women although evidence for Cr deficiency in humans is limited. It is believed to have a role in maintaining proper carbohydrate and lipid metabolism possibly be enhancing insulin signalling (Vincent 2004). Chromium is therefore important in the metabolism of carbohydrate, fats and stimulates fatty acid and cholesterol synthesis. It is thought to play an important role in brain function and is an activator of various enzymes that drive chemical reactions necessary to life. Chromium also has been suggested to play a key part in factors affecting glucose tolerance, which dictate the action of insulin. However, a number of recent reviews and meta-analyses have suggested that ' the supplement has no demonstrated effects on healthy individuals even when taken in combination with an exercise program' and supplementation of the diet with Cr would appear to have little, if any, value for healthy individuals (Vincent 2004). However, this may not be the case for people with altered glucose metabolism such as type 2 diabetes or gestational diabetes (See Vincent 2004, Havel 2004). But in most of these cases pharmacological doses of Cr were needed to have an effect, which may have health and safety, concerns. In May 2003 the Food Standards Agency in the UK concluded that Cr in the form of Cr picolinate might have the potential to cause cancer and advised consumers not to take Cr in this form. After reviewing the data Vincent 2004 concludes ' given that Cr picolinate might give rise to inheritable mutations and other oxidative cell damage and other forms of Cr3+ are readily available as nutritional supplements the action of the Foods Standards Agency appears to be reasonable'. Chromium chloride may be a more cost-effective solution. However, other reviewers come to a different conclusion and believe that chromium picolinate supplements are safe (Havel 2004).

Some research has been carried out regarding Chromium supplementation in the horse most of this in the last 10 years or so and again linked to the effects on glucose metabolism. In 1995, Pagan et al looked at the effect of chromium supplementation (5mg Cr/day via Chromium yeast for 14 days) on the metabolic response to exercise in trained horses. Using a standard exercise test, (SET), and thoroughbred horses it was suggested that chromium supplementation could affect the insulin response to a grain meal. However, the studies were undertaken 3hrs post grain feeding resulting in a reduction of glucose during the exercise bout which was more pronounced in the supplemented group (and probably undesirable) despite lower insulin levels in the supplemented group (suggesting perhaps an increased sensitivity to insulin). Cortisol levels were also found to be significantly lower at various points during the SET whilst triglyceride levels were significantly higher. It was suggested that the reduction in cortisol levels might be associated with differences in insulin status and that the rise seen in triglyceride levels might be related to insulin production and increased lipid mobilisation during exercise. However, these authors noted that in a later trial using untrained sedentary horses no effect of Cr supplementation was found. More recently Vervuert et al (2005) looked at the effects of feeding either no additional Cr (Cr free yeast) or either 4.14mg or 8.3mg Cr/day (as chromium enriched yeast) to horses undertaking a stepwise standard exercise test. In general there was little effect of the Cr supplementation although at speeds above 5m/s the horses on the Cr supplements had higher blood lactate concentrations. In addition, those on the 8.3mg Cr in fact tended to have higher plasma glucose concentrations at the highest speeds (being significantly different from the control group at 9m/s). These authors suggested that the exercise capacity of Cr- supplemented horses may in fact be compromised and therefore they recommended that Cr should not be given to horses.

Finally, Ott and Kivipelto (1999) designed a feeding trial to determine whether chromium supplementation would alter growth, development and energy metabolism of growing horses on high concentrate diets. Results of the study suggested that Chromium tripicolinate supplementation of yearling horses might increase the rate at which glucose is metabolised and may therefore lower the plasma glucose concentration. However, no effect of the chromium supplementation on growth rate was seen.

Rare Earth Elements : REE

The name rare earth elements (REE's) relates to elements with atomic numbers 58 to 71, which are neither rare nor earths! Initially, they were isolated as oxides and in some ways resembled calcium, magnesium and aluminium oxides, which are known as common earths. The rare earth metals or elements include yttrium (Y) and lanthanum (La) as well as the lanthanides Cerium (Ce), dysprosium (Dy); erbium (Er) europoum (Eu), Gadolinium (Gd) holmium (Ho) Lanthanum (La) Lutelium (Lu) neodymium (Nd) praseodymium (Pr) Samarium (Sm) terbium (Tb) thulium (Tm) and ytterbium (Yb). Their average abundance in the earth's crust ranges from 66mug/g for Ce to o.5mug/g for Tm and < 0.1mug/g of Pm. Transference from the soil to plants is also really low but there are some extreme accumulators and increasingly they are being used in East Asian agriculture in particular as fertilisers (Tyler and Olsson, 2005). REE's play very important roles in plant and microbes physiology and biochemistry (Qui et al 2005) and have been investigated as external markers for mean retention time measurements in ruminant animals (Bernard & Doreau, 2000) but do they have any role in the horse? One possibility is that in the future nanoparticles composed of one of the rare earth elements, cerium and yttrium, may be used to modulate oxidative stress in the horse! (Schubert et al 2006). However, Coudray et al, 2006, reports that REE's are believed not to be absorbed, hence their frequent use in as faecal markers in mineral absorption studies. For example, holium has been validated as a faecal marker in adult human copper absorption studies using stable isotopes (Harvey et al, 2002) and samarium, dysprosium and ytterbium as faecal markers in healthy adults during iron absorption studies (Fairweather-Tait et al, 1997). Ytterbium, for example, has been used as a faecal marker in a study by Pagan et al (1998) investigating the effects of exercise on digestibility, for exactly this reason. However, they can be found in herbs and other plants (Tyler & Olsson, 2005) and work in China has suggested that long term ingestion of high levels of REE's may adversely affect the activities of some digestive enzymes causing malabsorption and indigestion (Zhu et al, 2005). Use in horse would therefore warrant much further investigation.

What about the future ?

There is increasing interest in this whole area and, in particular, the area of natural remedies. However, there presently seems to be more marketing hype than scientific support and there is clearly a need for further work to confirm or refute the various suggested claims for the all of these more unusual feedstuffs. More in depth reviews are needed which critically evaluate the data currently published and its potential relevance to the horse. In addition, further investigation is also warranted surrounding the use of spices and other unusual feed stuffs with regards to contraindication's following their use and the level of bioavailability when fed to the horse.

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